Using Control Automation to Monitor and Control the Pyrolysis of Peanut Shells

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Abstract

Using Control Automation to Monitor and Control he Pyrolysis of Peanut Shells into Hydrogen. JOHNNY M. DEVINE II (Albany State University, Albany, Georgia 31705) Calvin Feik (National Renewable Energy Laboratory, Golden, Colorado 80401).

Petroleum resources in the world today are diminishing as fast as they are being produced; the answer to this is biomass. By performing a process by the name of pyrolysis you can break the biomass down into hydrogen and other gases. The processs of pyrolysis requires the use of many machines and pieces of equipment that need to be monitored and controlled some kind of way. The program Opto 22 Factory Floor is used to monitor and control the process. This program uses a PC with Windows 95 or NT to run the machinery. Opto 22 Factory Floor does not require the user to know any particular programming language. This program is one of the most widely used control automation software tools in the market today. It is by far easier to use that the UNIX system that was previously in use in the TCUF. The machinery that uses a nickel base catalyst to perform pyrolysis on the biomass is not yet designed. Also the equipment used to measure the percent output of gases needs to be redesign all on this Opto 22 Factory Floor program. With this the equipment will be able to be used more efficiently and also be easily transported to the test site in Georgia.

Research Category

ERULF: Physics Chemistry Biology Engineering Computer Science **Other_____**

CCI: Biotechnology Environmental Science Computing

TYPE ALL INFORMATION COMPLETELY AND CORRECTLY

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Introduction

In today's society, traditional resources for energy are either becoming scarce and causing prices to rise or are too harmful to the environment. This is seen today with the increasing cost of gasoline and other petroleum products. With increasing demand and decreasing supply makes it a must that researchers find an alternative fuel to supplement or replace the withering supply of oil. The production of renewable hydrogen could be the solution. The production of hydrogen by the processing of pyrolysis products that are byproducts of activated carbon is one path that could be demonstrated in the near future. The concept is based on producing hydrogen from biomass oils in conjunction with other products that have greater value and can reduce the cost of hydrogen. The original idea was that the pyrolysis oil could be separated into two parts based on water solubility. The water-soluble fraction is to be used for hydrogen production and the water insoluble fraction could e used in adhesive formulation (Kelley et al., 1997). Although this option remains viable, commercial deployment opportunities for the hydrogen linked to the adhesive coproducts are not in the near future. Therefore alternatives had to be developed based on the coproduct strategy. The conversion of biomass to activated carbon is another route to hydrogen with a valuable coproduct. In the first of activated carbon process slow pyrolysis is used to maximize the yield of charcoal and organic vapors that are produced as a by-product.

The process, which is by computer controlled, involves making activated carbon from densified peanut shells. The computer control system that is being used for the TCUF is Opto 22 Factory Floor. Opto 22 automation products are used in every industry where process control is critical, from agriculture to aerospace. Dairy farmers use Opto 22 components to control milk processing and elevator manufactures use controllers by the hundred. This program allows a user to control and monitor the entire plant and take corrective measures from a computer in real time, meaning that it is happening when you see it. This program allows for a user to see real time data from the factory floor in the form of graphs or bitmaps that he or she can create. This is done by connecting points in the TCUF to a controller, which is then relayed to the computer program. In the TCUF there are two controllers Mistic I and Mistic II that every point must be connected to. Each controller consists of bricks, which contain 16 I/O points each. I/O points are objects that are out in the plant that collect data or are used to input data, such as temperatures or flow rates. (Control for the cart that measures the flow rate of gases that passes through the plant.)

Also in the TCUF is a two-inch reactor that has a Molecular Beam Mass Spectrometer (MBMS) this is just a smaller scale of what is going on with the * inch reactor. The difference in the two is that the two-inch reactor is only testing to see what is happening to the biomass at the different temperatures along the process of turning it into hydrogen, that is the purpose of the MBMS. The two process also uses a computer control except that it is not as of an advanced program meaning that it wasn't design to handle as many points that are in the eight-inch reactors process.

Pyrolysis also can be done on a small scale and not just in a factory. One example is found on a small island in the Philippines. There scientists and researchers have taken a small version of the process and incorporated it into people's lives, by using coconut shells to form energy from hydrogen. Now the small island has power to run radios and equipment for weaving, and this is raising their standard of living. Soon the island will be able to trade with other islands and prosper.

The process that is being tested in the TCUF is going to be shipped to an industrial site in Blakely, Georgia for Phase II testing. Southwest Georgia was identified as an excellent opportunity because of the importance of agriculture and the need for zero emission transportation fuels in the Atlanta area. Scientific Carbons Inc. in Blakely, Georgia uses palletized peanut shells as the feed material for the production of activated carbon. This will be used as the development site. A slipstream of pyrolysis vapors produced in the 100 kg/hr continuous pyrolysis unit will be used fort the long duration steam reforming test. This will hopefully work well enough to be able to proceed with Phase III of the research. Phase III of the research consist of using the hydrogen produced from the Blakely shelling plant and power a bus in the nearby city of Albany, Georgia, on the campus of Albany State University for. This integrated strategy will demonstrate the potential impact of hydrogen and bioenergy on the development and diversification of rural areas.

Materials and Methods

Placing Points in OptoControl

For a piece of equipment to be controlled through Opto 22 the points must be placed in OptoControl. OpoControl is where every point is with a description, module number, location in controller, and which controller contains it. OptoControl is also where the points are given assignments or specifications as to what their duty is whether it is read data or send data. Points for the new reformer where to placed in OptoControl in Mistic I brick 107. Although brick 107 already has two points there, those two points were to be placed in brick 105 and the new points would occupy all of brick 107. The first step in wiring a controller is to make sure that there is no power running through the controller. Once the proper precautions have been done to make sure that there is no power being transmitted through the wires, the connection of the points takes place. When connecting the wires you run it from the specified brick to the proper power connector. Once all points are connected then the cover of the brick is replaced and power is turned back on.

Designing the Controls for the GC Analytical Cart

Designs for the GC Analytical Cart are being placed on Opto 22 due to the fact that the UNIX, The system that the controls were previously on, cost too much money to maintain. The UNIX system is a system that is not as user friendly or easily learned, so for this purpose of having to transport and teach to new workers Opto 22 is used. When designing a new control for a piece of equipment the first task is to open a new window and to give it a name. The name that will be given to this window is GC Analytical. With this step you can design the equipment in Opto 22 or design it on another design software and import it onto Optp22 as a bitmap. The designs for the GC Analytical Cart are done in Opto 22 Configuration mode. Since an operating system for the cart had been designed in the UNIX system, which is the old control automation for the TCUF, the design in the

Opto 22 was made to look similar to that of the UNIX. Once the design is placed on the new window points must now be inserted so that the new windows connects to the device it represents.

Designing Controls for the Reformer

Designing controls for the reformer consisted of copying and pasting a previous design. Since the reactor and the reformer had the same basic design the image that was being used for the reactor is copied and pasted onto the new reformer window. Once the reformer was there the design for the piping had to be placed in the window. Once all the piping was is and the points placed in their respective places the controls for the reformer will be complete.

Instaling the GC Analytical Cart

The GC Analytical Cart consists of many instruments. The First instrument that needs to be placed in the cart was the flow gauge. Its position is at the top of the cart so it is the first to be placed in the cart. This next piece of equipment is the paramagnetic oxygen sensor, which measures the percent of oxygen that is in the final product of gases. The next two pieces of equipment are the NDIR or Nondispersive infrared sensors. These two black boxes read the percent of carbon monoxide (CO), carbon dioxide (CO_2), and methane (CH_4) that are in the final product of gases. Once all these have been placed in the cart two gas chromatography units are put in the cart. The use of two is required so if one of the units happens to stop working the other could be substituted with out a problem. These two units read at which point the gases separate from each other. Once all the instruments that read data are placed in the cart securely the piping is done. Piping is done so that the gases may be transported into the cart and from one instrument to another. Piping is done with five types of tubing; quarter inch inner diameter Teflon and stainless tubing, eighth inch inner diameter Teflon stainless tubing, and eighth inch inner diameter copper tubing.

Results

Producing hydrogen as a by-product of biomass seems to be the best alternative to petroleum products. The only key factors are being able to produce the hydrogen in the large scale for a period of time and to be able to do it a competitive price with other forms of fuel. Also the Opto 22 seemed to be the best control automation software to use being that this facility will be transported down to Georgia. So the overall thought of producing hydrogen, this seems to be the best alternative overall of a renewable fuel. No test had been run yet in the TCUF with any of the equipment that was designed on Opto 22 Factory Floor software. Test will not begin until the following week in which I will not be here.

Discussion and Conclusion

The Opto 22 Factory Floor program seemed to be the most user-friendly control automation software being since the UNIX system uses the C programming language which gets to be very difficult when modifying a project. Also with the C programming language one set of commands can delete all your work with no undo button or back button to correct your mistake. Also along with the fact that Opto 22 works with any computer with Windows 95 or better it is a program that takes little more that the purchase of the software and bricks to be up and running.

Acknowledgments

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Figure 1: GC Analytical Cart

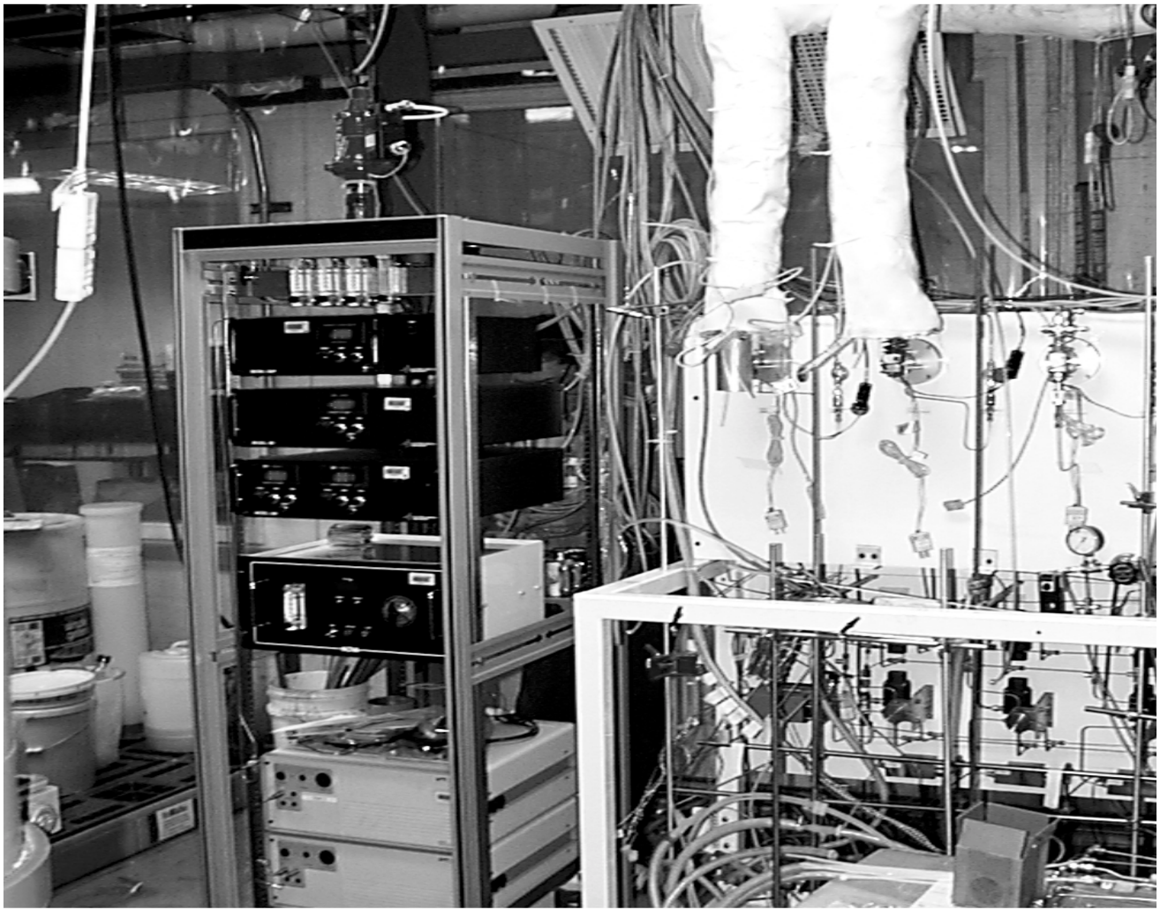

Figure 2: UNIX Work Station

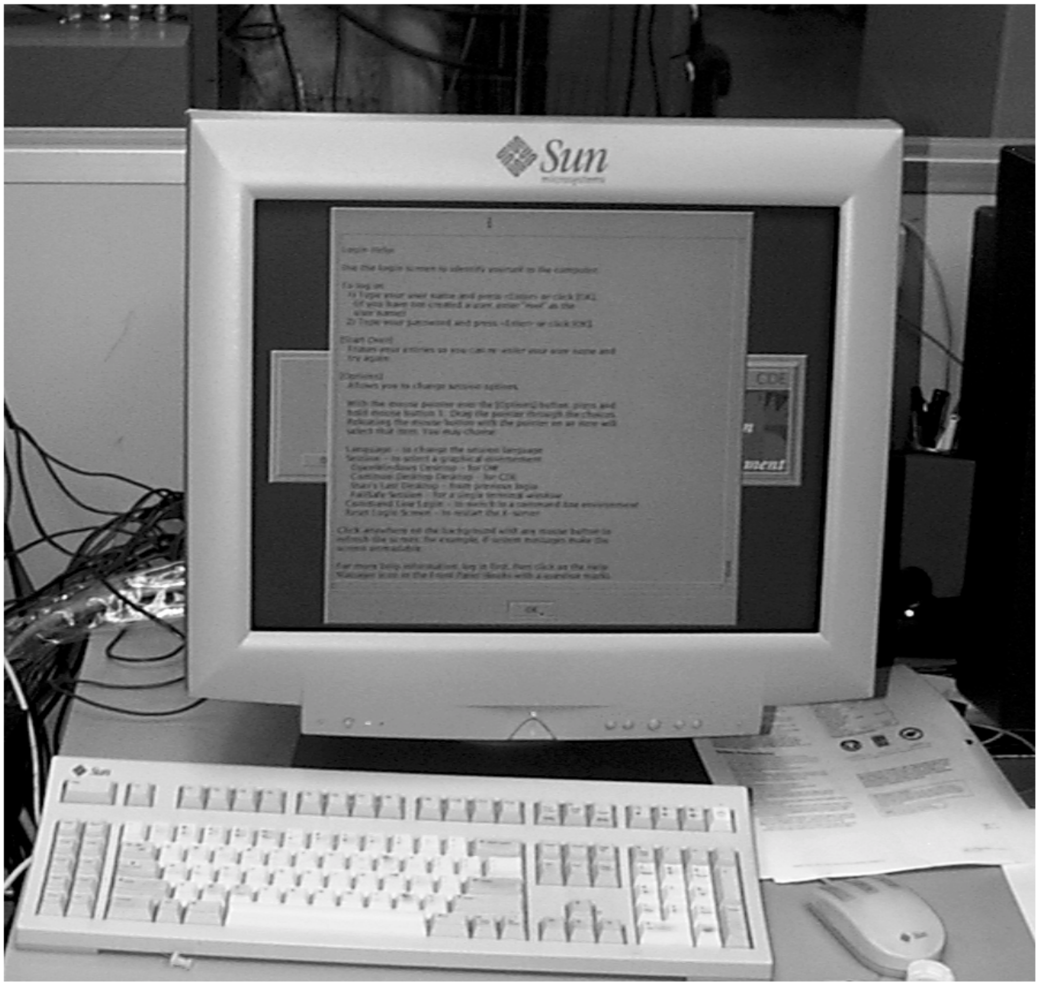

Figure 3: Opto 22 Factory Floor Control System

Figure 4: Mistic I and Brick 107